

Deep Space CubeSat Prototype Platform Design and Testing

Completed Technology Project (2013 - 2014)



Project Introduction

This IRAD will significantly advance a GSFC Deep Space CubeSat prototype effort in almost all subsystems. Because it represents a “tall pole” for lunar orbiters, as well as orbiters for some planets and for many CubeSat-based surface instrument packages, a major focus in this IRAD is on thermal modeling and thermal vacuum testing using COTS hardware or thermally-valid mass models (where required due to expense of flight-qualified components); building on the work of our FY13 IRAD, the requirements for optimizing the prototype to be tested will push the development of all the subsystems. With the completion of this IRAD, GSFC will possess a design that is ready for proposal to outside opportunities, such as those of the Office of the Chief Technologist, for application to lunar, Martian, asteroid, and other planetary targets as orbiters, impactors, or surface instrument packages based on CubeSat architecture. The payload for this prototype effort will be an instrument which presents the greatest ‘compactness’ challenge, the optical subsystems of a compact yet capable, high spectral resolution, broadband Infrared spectrometer. This instrument could provide the basis for low cost, high priority science missions to perform spectral reflectance studies for systematic determination of mineral and volatile distribution on a range of solar system bodies, such as water form and component distribution as a function of latitude, time of day, and terrain, on the lunar surface, as well as to establish GSFC leadership in the development of CubeSat-capable instrumentation for missions of far lower cost access to deep space.

We propose to develop and test a proof of concept prototype for a standard CubeSat form factor platform, designed for missions to deep space targets, as opposed to the conventional LEO CubeSat venue to date. In testing, we will focus on the “tall poles” identified in the FY13 LunarCube IRAD study, for a variety of lunar targets. Tall poles include thermal issues, radiation effects, adequate power, communication links, limited mass and volume for subsystems, and propulsion from Earth to the target. Lunar applications, like the LWaDi lunar water distribution CubeSat orbiter, typically have major thermal challenges as a “tall pole”, especially when the detectors need to be cooled or the packaging is very dense. For this IRAD, we will *perform relevant thermal vacuum testing of the prototype platform using the detailed LWaDi mission thermal profile, to confirm that the design for LWaDi and similar missions will work and to drive the deep space CubeSat platform to a design level that is ready for external proposals.* Other constraints, including propulsion, power, attitude control, C&DH, and communications, will continue to be analyzed in parallel with thermal testing, and relevant, reusable COTS parts will be included in the prototype, per available funding. It should be noted that the discipline engineering team assembled for the FY13 IRAD will be available to significantly advance the prototype model. The end product will be a hardware CubeSat bus design (6U for deployment at the final target, 9U for deployment from GEO requiring a robust propulsion system to reach the target) that is understood from thermal, mechanical, and other perspectives,



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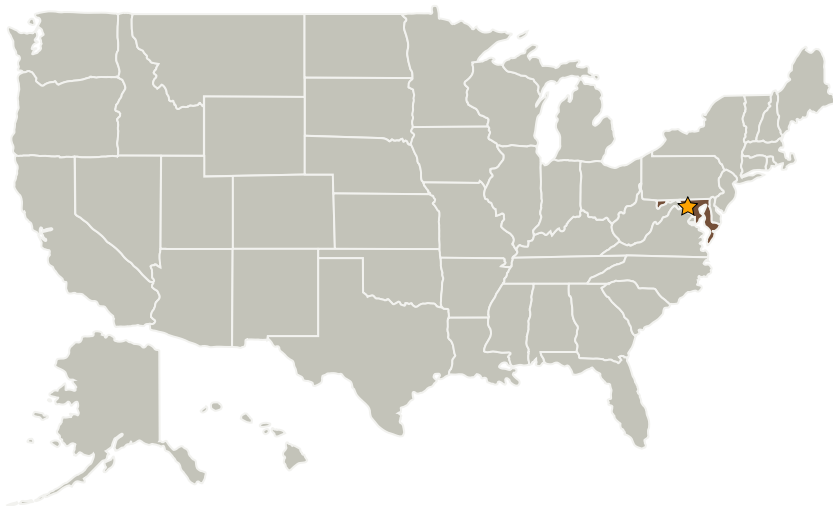
and ready for flight development. As an additional payoff, we will also work to apply relevant test results to other mission profiles that we are developing, including impactors and surface instruments based on CubeSat standards, with various trajectories and life times.

In addition, we propose to deliver a detailed design and development plan, and to test a prototype of the optical subsystem, the component which represent the greatest 'compactness' challenge of a compact yet capable version of a cubesat 'work horse' instrument, an extremely compact (<2U) high spectral resolution (10nm), broadband IR spectrometer capable of measuring volatiles (water type and component, organics) and Fe- and Ti-bearing mineral distribution on a broad range of solar system bodies, including the Moon, where we propose to use it to determine water type (bound, adsorbed, ice) and component distribution from spectral features in the 1.3 to 3.7 um range for the LWaDi (Lunar Water Distribution) mission.

Anticipated Benefits

This project, when fully completed, will increase NASA's options for flight missions.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

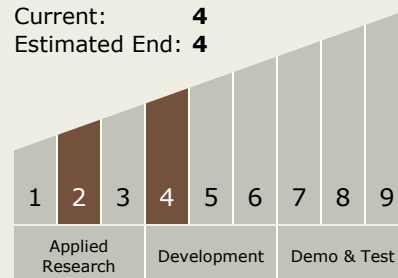
Brook Lakew

Principal Investigator:

Robert J Macdowall

Technology Maturity (TRL)

Start: 2
Current: 4
Estimated End: 4



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Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Project Website:

<http://sciences.gsfc.nasa.gov/sed/>

Technology Areas

Primary:

- TX07 Exploration Destination Systems
 - └ TX07.1 In-Situ Resource Utilization
 - └ TX07.1.1 Destination Reconnaissance and Resource Assessment